

Tropical Ice Clouds - Are we in the ballpark?

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Use QUICR products - ACRED retrievals to provide realistic range of ice cloud properties

Have data products which provide range of uncertainty
(details/discussion Zhao et al. 2012 and Comstock et al. 2013 papers)

Can these retrievals constrain the model's Tropical ice cloud properties in a meaningful way?

- Where does model fall within the range of retrievals?
- How confident are we in the results, considering uncertainty introduced from model side?
- How to reduce model error?

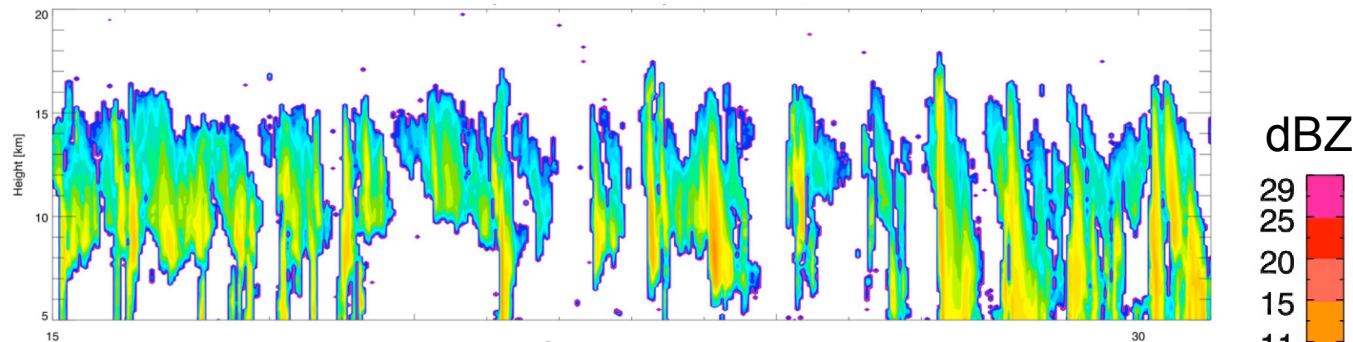
Assumptions and decisions - uncertainty from the modeling side

- Which hydrometeors to include? (ice, stratiform/convective snow)
- How do clouds and precipitation overlap?
- Which part of the cloud/precip is observable? (requires forward model)
- Bulk (grid box or hourly average) quantities or high resolution (10s, subcolumn)?
- Microphysics assumptions in forward model (i.e. ice habits and properties)

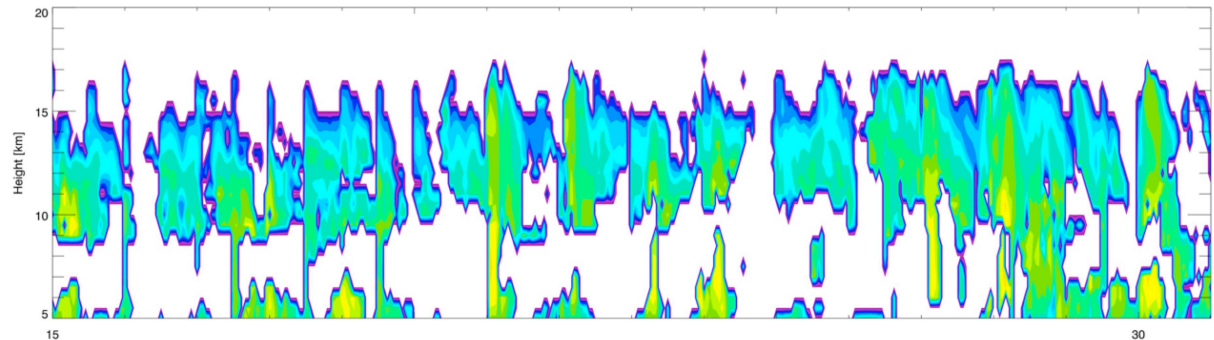
Radar reflectivity

- Precip must be included to get realistic radar reflectivity
- Precip fraction and overlap critical for hydrometeor occurrence in 8-12km range
- Bottoms too low, AWP appears too high
- Relevant for radiative transfer - local or “in-cloud” values depend on fraction

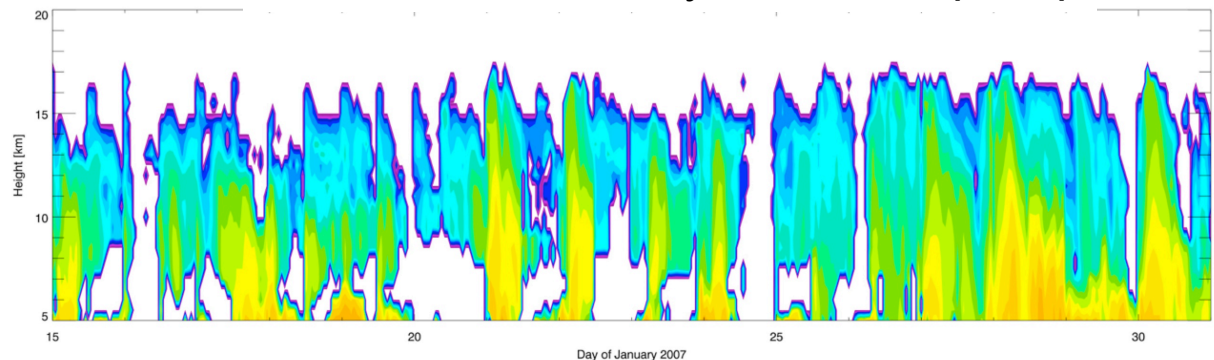
Radar observed (cirrus mode), Darwin



Model sim reflectivity, cloud only

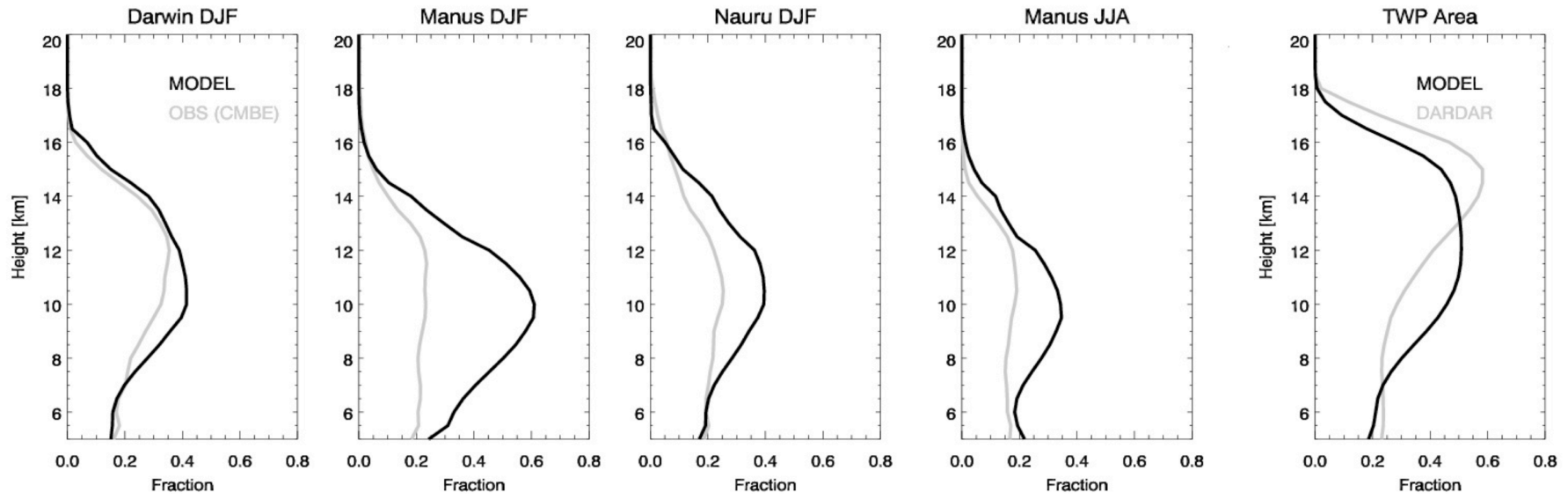


Model sim reflectivity, cloud and precip



Consistent picture emerges

Profiles of hydrometeor occurrence

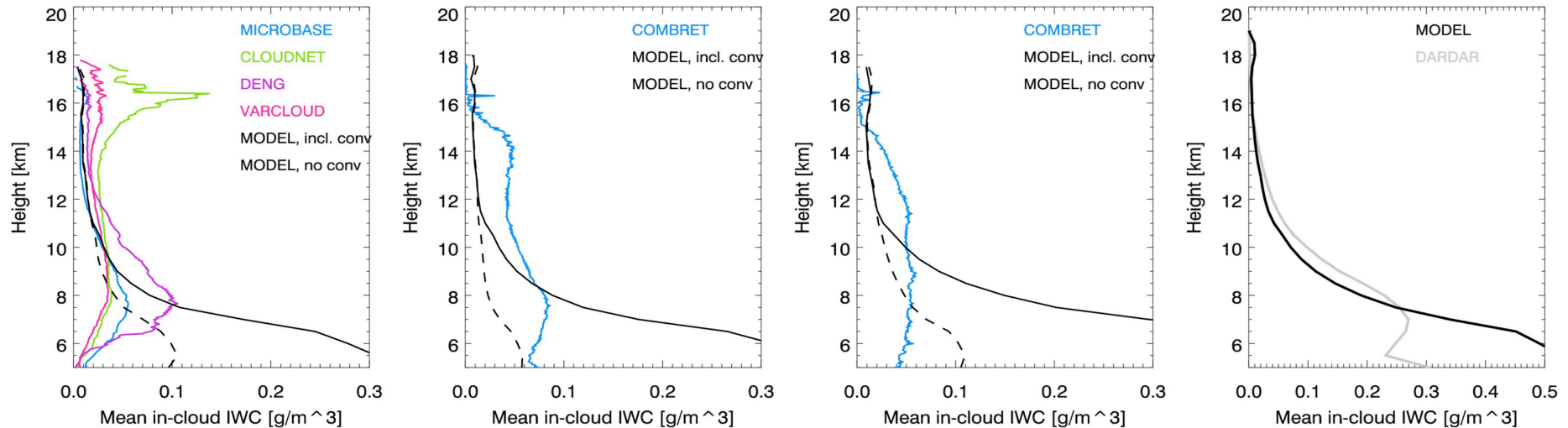


Mean in-cloud IWC,
Darwin, DJF

Mean in-cloud IWC,
Manus, DJF

Mean in-cloud IWC,
Manus, JJA

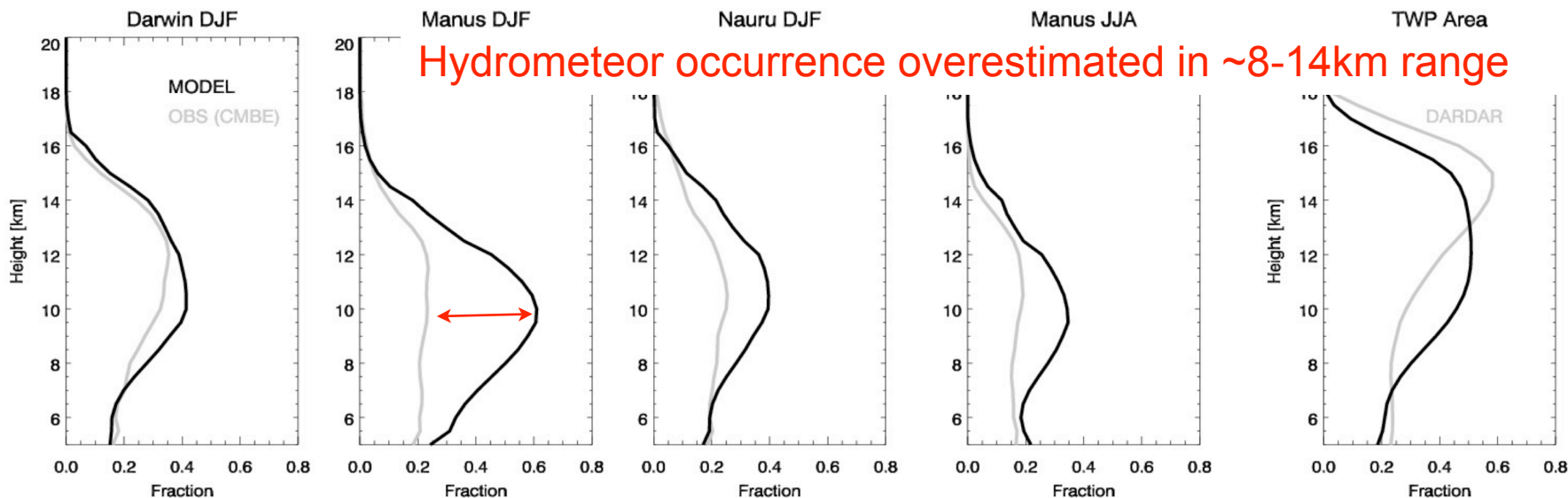
Mean in-cloud IWC,
TWP Area



Consistent picture emerges

Profiles of hydrometeor occurrence

Hydrometeor occurrence overestimated in ~8-14km range

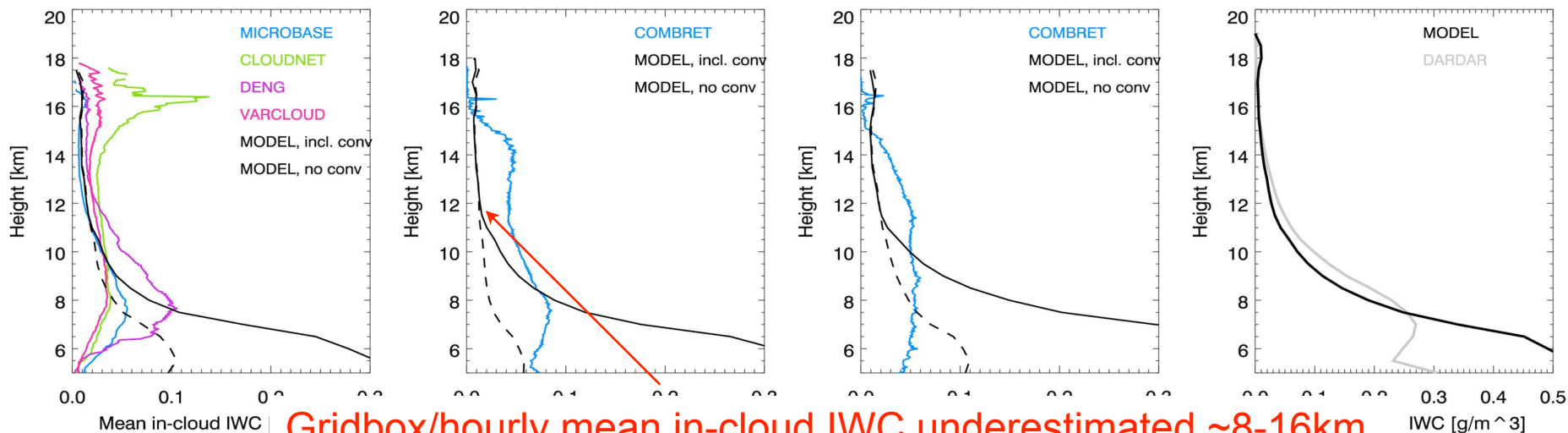


Mean in-cloud IWC,
Darwin, DJF

Mean in-cloud IWC,
Manus, DJF

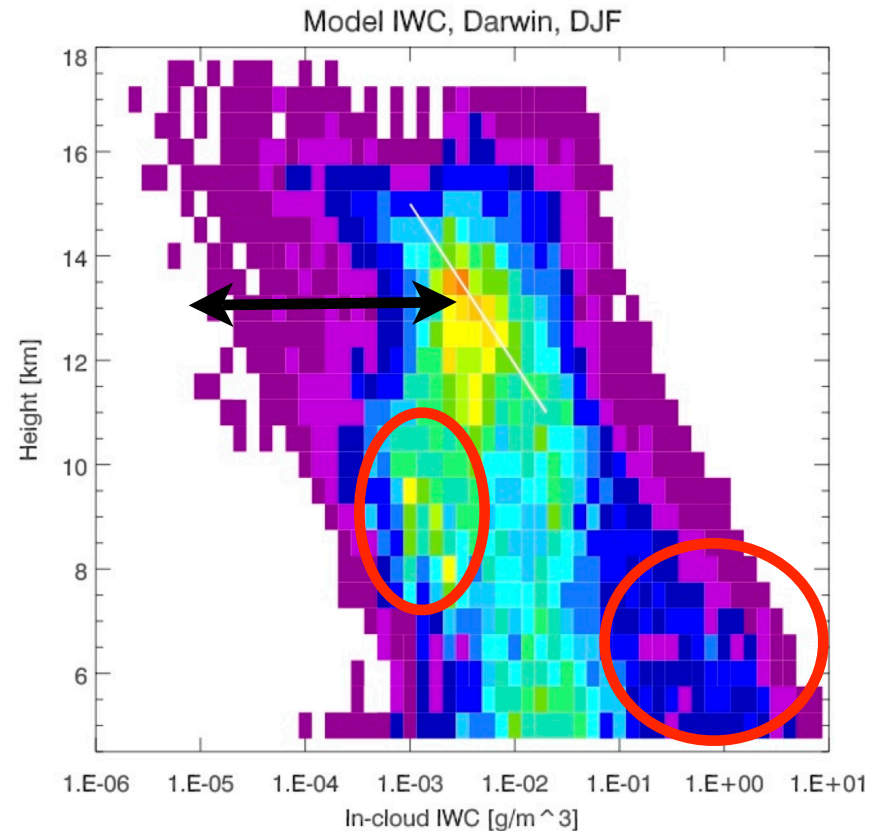
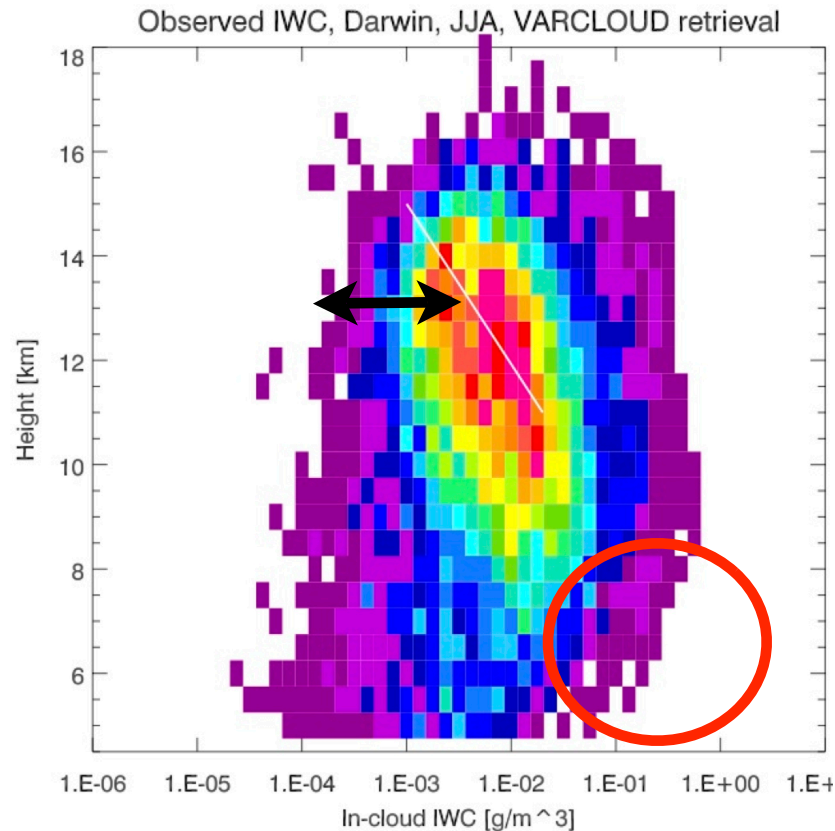
Mean in-cloud IWC,
Manus, JJA

Mean in-cloud IWC,
TWP Area



Gridbox/hourly mean in-cloud IWC underestimated ~8-16km

Box mean/hourly in-cloud IWC (Darwin DJF)

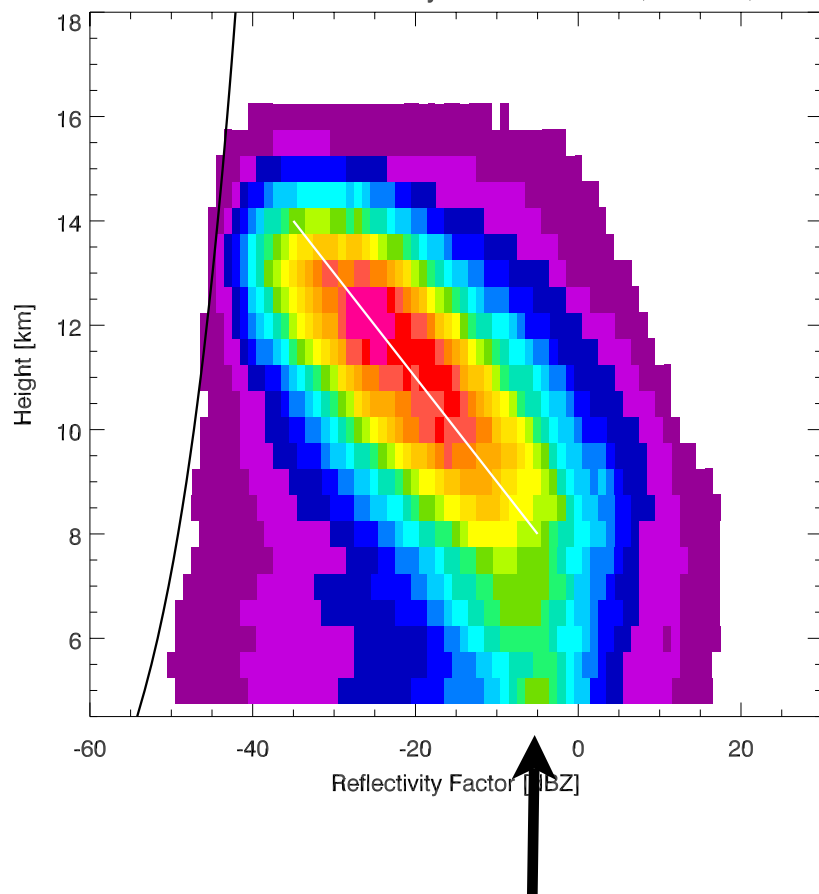


convective precip signature - not in obs, signal attenuated
stratiform precip signature
model has longer tail to low IWC values,

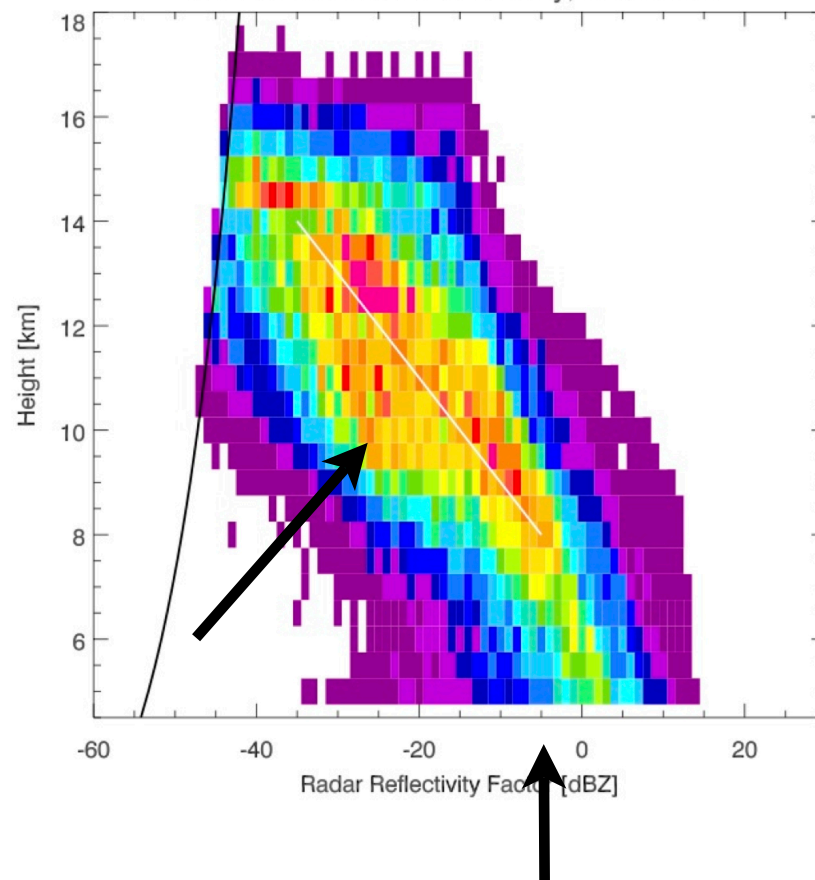
Darwin DJF reflectivity

“in-cloud” 10s observations, 20 model subcolumns

CFAD of MMCR reflectivity in Cirrus mode, Darwin, DJF



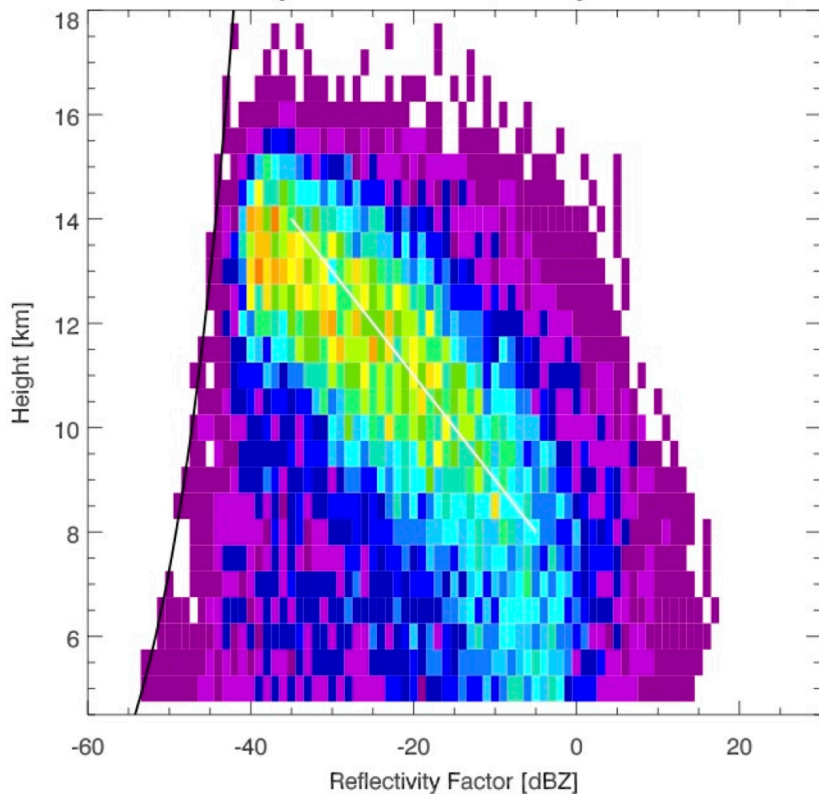
CFAD of simulated reflectivity, Darwin DJF



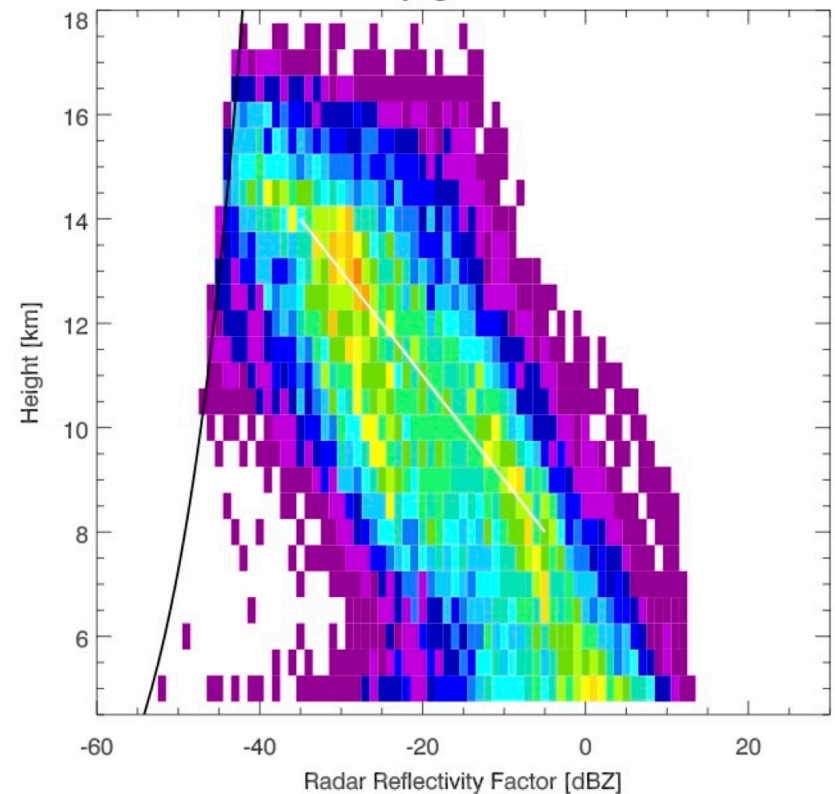
Darwin DJF reflectivity

hourly/ grid box average “in-cloud” reflectivity

CFAD of MMCR reflectivity in Cirrus mode, hourly in-cloud mean, Darwin DJF



CFAD of simulated reflectivity, grid box in-cloud mean Darwin DJF



Processes of interest

- Improved subgrid representation of clouds and humidity (high temporal resolution observations of cloud water, humidity, precip)
- Liquid autoconversion/accretion (e.g. co-variance/correlation of LWC and precip, Boutle et al. 2013, Lebsock et al. 2013)
- Ice autoconversion (e.g. relate turbulent motion to autoconversion timescale, Ma et al. 2012)

single moment microphysics

